

REMARKS

This responds to the Office Action mailed December 29, 2008, for the above application in which claims 1-3 and 5-10 are pending, claim 4 having been withdrawn from current consideration.

Response to Objection to Specification

The Patent Office has objected to the Abstract due to the use of certain terminology. The Abstract has been amended hereby to correct the items identified. Accordingly, withdrawal of the objection to the specification is requested.

Response to Objections to the Claims

The Patent Office has also objected to claims 6-10 due to improper multiple dependency. Claims 6-9 have been amended to correct the multiple dependency. Accordingly, withdrawal of the objection and consideration of claims 6-10 on the merits is respectfully requested.

Response to Art Rejections

Claims 1-3 have been rejected, under 35 U.S.C. 103 for obviousness over Glisin et al., U.S. Pat. No. 6,438,234 (Gisin) in view of Boyd et al., U.S. Pat Publication No. 2003/0231826 (Boyd). Claim 5 has been rejected on the same grounds based upon Gisin and Boyd in further view of Wright et al., U.S. Pat. No. 6,552,800 (Wright). Applicants respectfully disagree on all accounts because neither Gisin nor Boyd, individually or in combination, involve the frequency domain as is clearly specified by the claims and there is nothing in the prior art that would suggest any way that they could, or should be modified and combined in a manner that would result in the claims or any colorable obvious variant thereof. Moreover, Wright does not remedy the deficiencies of Gisin or Boyd.

Gisin concerns the secure transmission of a cryptographic key from a transmitter to a receiver. Specifically, Gisin describes “time binning” of photons using an asymmetric Mach-Zhender Interferometer for quantum key distribution. In Gisin both the transmitter and receiver operate in collaboration with each other to communicate information over two channels, while ensuring the same overall time delay is experienced in each of the two channels. In other words Gisin describes an arrangement where there is no overall differential time delay between input and output signals and no effect on frequency. In addition, all the signals of interest in Gisin are at the same frequency. The phase modulator operates to introduce a relative phase (not frequency) difference between the two signals in order to transmit information. The document explicitly uses single photons that will have very short temporal extent. The path length difference introduces delay in the time domain (i.e. phase), but does not cause a change of frequency at all.

Boyd concerns the manipulation of optical pulses for implementing an optical switch or for pulse shaping. Boyd modifies the effective propagation constant to introduce phase changes into the modified channel. Boyd specifically uses an optical waveguide that is optically coupled to plural resonators that modify the effective propagation constant of the waveguide to manipulate the optical pulses. The resonators are controlled by varying, for instance, their refractive index or finesse values. Like Gisin, it does not change the frequency of the signals.

Since neither Gisin nor Boyd operate with altered frequencies, no combination of the two would do so either.

Claim 1 specifically recites, a “frequency beamsplitter for us in the frequency basis” as well as that the photons are “separated in frequency space by radio or microwave frequencies”

and further states that there is "a time delay element to introduce a differential time delay into the second path such that a pair of input photons are separated, by the time delay element, in the frequency space" each independently thereby clearly distinguishing the claims from Gisin, Boyd or some combination thereof.

In addition, applicants respectfully disagree with certain Patent Office assertions about the applied references. These are addressed in turn.

First, the Office Action at page 4 asserts that Boyd "teaches a time delay element (12(1)-12(n), resonators) that separates each of a pair of input photons by radio or microwave frequencies [0026, 0061,0102]" This statement is incorrect. There is no teaching of frequency changing in Boyd. Paragraph [0026] describes the resonators 12(1)-12(n) and their arrangement, in particular their spacing. [0061] refers to Fig. 1 and describes how an input pulse acquires a frequency dependent phase shift. It does not describe any shift in frequency; only in phase. Paragraph [0102] refers to Fig. 7 and describes the evolution of pulse shape as it passes through 100 resonators - it is dispersed and peak power is reduced. There is no disclosure of frequency separation between a pair of photons, merely a phase shift at constant frequency.

Second, the Office Action states "The separation time delay frequency of 88Ghz is calculated using a phase shift of 2π , an index of refraction of 3.4, a distance d of $1000\mu\text{m}$,..., and where c is the speed of light" and notes that 88Ghz is a radio or microwave frequency. This calculation purports to show that an introduced phase shift of 2π is equivalent to a frequency separation between two photons. This position does not withstand close scrutiny:

The Patent Office takes one wavelength of an optical signal (a phase shift of 2π) to be the separation $10\mu\text{m}$ in each resonator \times 100 resonators = $1000\mu\text{m}$ or 1mm. This itself is incorrect.

The Patent Office then multiplies the alleged wavelength by the refractive index of the resonator to get an adjusted wavelength of 3.4mm. This wavelength is then divided into the speed of light $3 \times 108\text{m/s}$ to get $88 \times 109\text{ Hz}$ (or 88 Gigahertz). While this resulting calculated frequency is a radio or microwave frequency, what does it mean? If the wavelength is correct, the Patent Office calculation just tells one the frequency of the optical signal inside the resonator. It does not teach or otherwise even imply or suggest generation of two frequency modes from that optical signal.

Accordingly, it is respectfully submitted that independent claim 1 is allowable over the cited references. Since claim 1 is allowable, applicant is entitled to have claim 4 rejoined since it is linked by an allowable claim. Claims 2-10, being dependent from allowable claim 1 are also allowable for the same reasons.

AUTHORIZATION

No fee beyond the extension fee is believed to be due for consideration of this Amendment And Response on the merits. However, the Commissioner is authorized to charge any additional fees which may be required for consideration of this paper, or to credit any overpayment, to Deposit Account No. 504827, Order No. 10044435-001US.

Respectfully submitted,

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